



Plasma Confinement for Thermonuclear Generation of Neutrons and Energy

**Farrell Edwards &
Eric Held**

Team

- Farrell Edwards, USU, Physics
- Eric Held, USU, Physics
- Rick Nebel, LANL, consultant
- Don Baker, LANL, consultant
- Jeremy Bishop, graduate student, USU
- David Hatch, undergraduate, USU
- Ray DeVito, Technology Commercialization Manager

Products of Thermonuclear Fusion

- Energy
- Neutrons

Commercial uses of neutrons

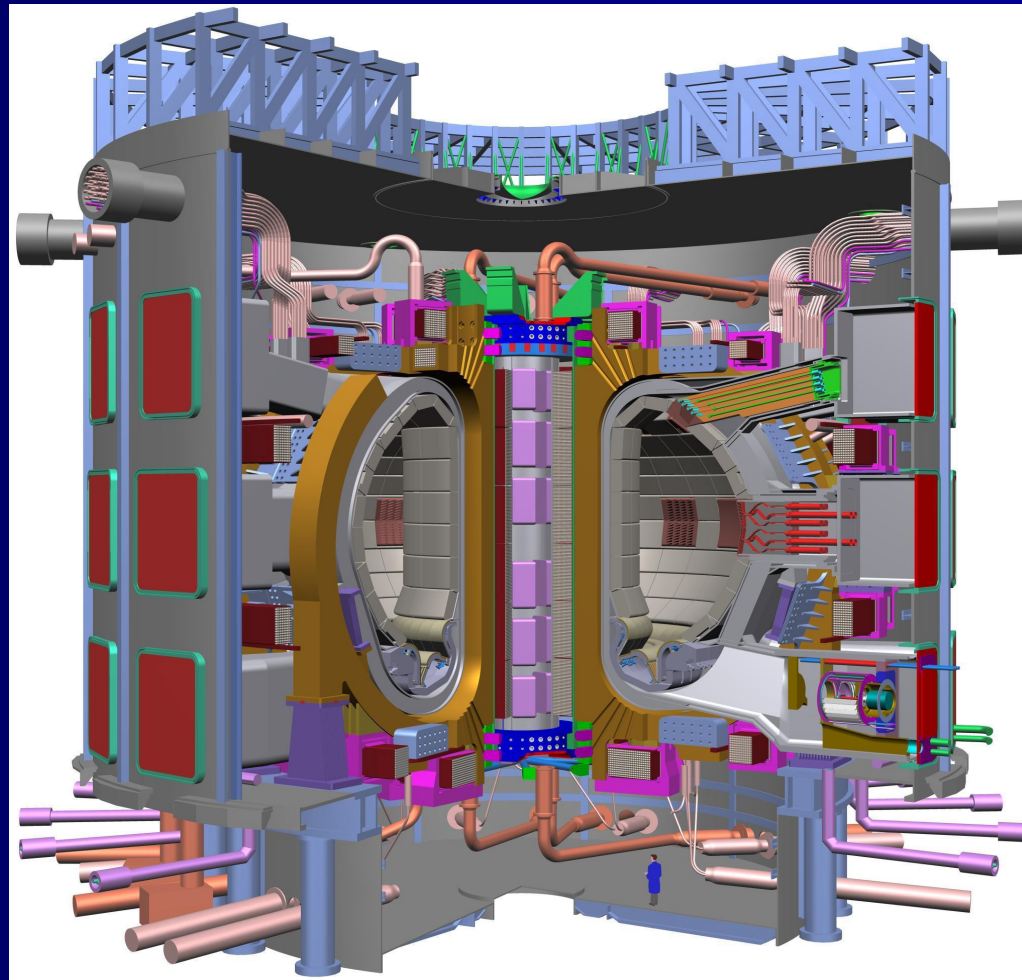
- Scan airport luggage for bombs
- Detect unexploded land mines
- Cancer diagnosis
- Oil well logging
- Measure moisture in soils and concrete
- Examine interior of machine parts

Many fusion confinement schemes

- Equations governing plasma confinement
- Many equilibrium solutions
- Of them many work — to a degree
- Construct a unit based on a solution
- For example
 - Plasma Focus (commercialized)
 - Stellarator
 - Tokamak

Tokamak: International Thermonuclear Experimental Reactor (ITER)

Cost: \$5,000,000,000



USU Solution

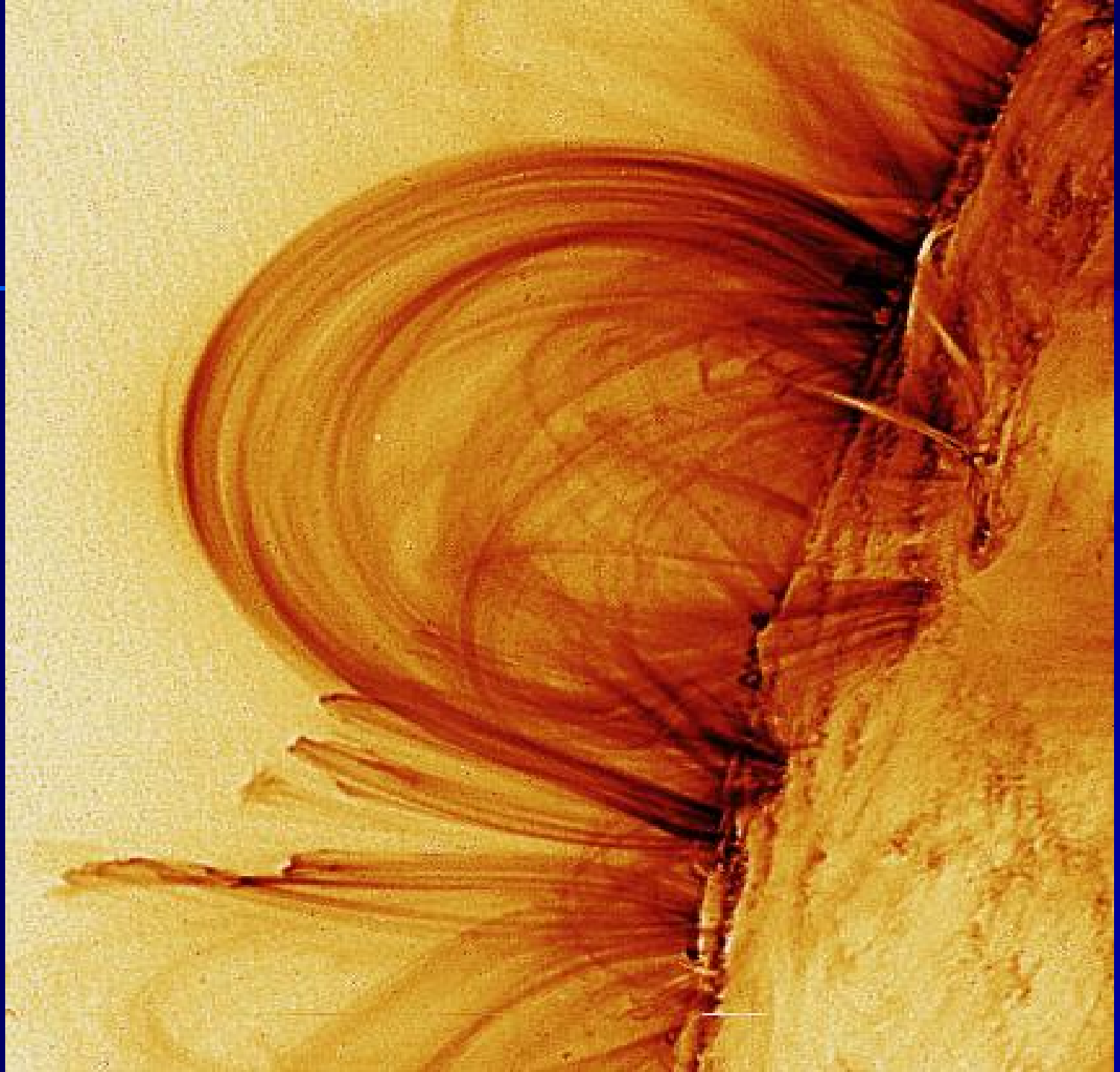
- Based on the same fundamental equations
- A unit would have the same basic shape and construction as tokamak
- Different relationship between magnetic field, plasma density, and temperature
- Much smaller size – this is required.

Advantages of USU device

- Size: could fit under the hood of a car
- **Stability: Minimum total energy**
- High neutron flux: 1000 or more times that of the competition
- Cost: \$20 K - \$200 K

Evidence

- Based on time-tested confinement theories
- Publication in *Physical Review Letters* (Dec. '04)
- State observed in nature (The only one that is!)



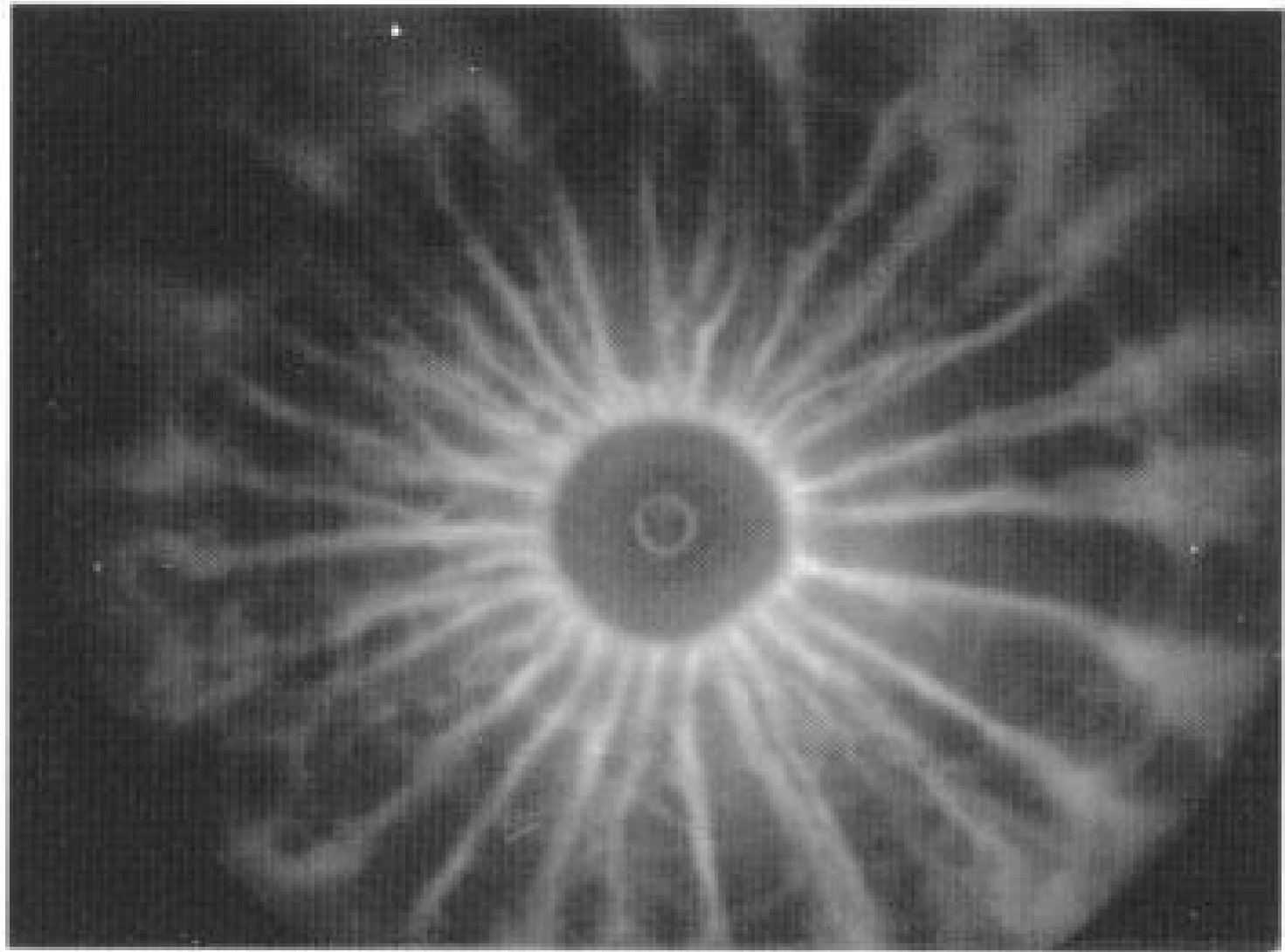


Fig. 6.13a. As the sheath carrying the inward-moving current forms, pairs of vortex fila

Market Analysis: Neutrons

Application	Market (Units)	Cost per Unit	Market Penetration	Estimated Sales
Airport Luggage	40,000	\$200 K	100%	\$8,000 M
Neutron Radiography	1,000	1000 K	30%	300 M
Oil Well Logging	2,000	120 K	20%	48 M
Cargo Container	1,000	1000 K	100%	1,000 M
Unexploded Mine	1,000	500 K	70%	35 M
Gross Sales				\$9,383 M

Present Status of Project

- Patent applied for (Mar. '04)
- Paper published (PRL, Dec. '04)
- Team assembled
- Prototype design and construction proceeding
- Major funding received (~\$200,000)
- Companies are interested in producing the product
- Several investors are interested

Next steps

- Secure additional funds, ~\$100 K
(Dec. '05)
- Finish prototype (Dec. '06)
- Adapt to neutron application (Dec. '07)
- Adapt to energy production (Dec. '08)